

New Photometric Observations of σ Ori E

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Abstract. We present new *UBVRI* observations of the magnetic Bp star σ Ori E. The basic features of the star's lightcurve have not changed since the previous monitoring by Hesser et al. (1977), indicating that the star's magnetosphere has remained stable over the past three decades. Interestingly, we find a rotation period that is slightly longer than in the Hesser et al. (1977) analysis, suggesting possible spindown of the star.

1. Observations

The helium-strong star σ Ori E (B2Vpe) is characterized by 1.19 d-periodic modulations in its H α emission, helium absorption-line strengths, visible and near-IR photometric indices, UV continuum flux and resonance-line strengths, 6 cm radio emission, linear polarization, and longitudinal field strength. The most current comprehensive photometric observations of the star are by Hesser et al. (1977). Recently, Townsend et al. (2005, hereafter T05) have demonstrated that the *Rigidly Rotating Magnetosphere* (RRM) model developed by Townsend & Owocki (2005) can furnish a good fit to these observations (see also Townsend, these proceedings).

In this contribution, we present fresh photometric observations of σ Ori E, obtained with the dual aims of further testing the RRM model and searching for any changes in the star's circumstellar plasma distribution. Beginning 17th November 2004, we conducted 14 nights' Johnson-Cousins *UBVRI* CCD photometry of the σ Ori system, using the 0.9 m CTIO telescope made available through the University of Delaware's membership of the SMARTS consortium. The filter sequence *UVUVVBRI* was adopted, and a neutral density filter was employed to prevent CCD saturation. The choice of too high a filter extinction on the first night rendered the data from that night unusable.

The observations were reduced using standard procedures (flat fielding, zero subtraction etc.) in IRAF. PSF fitting was employed to extract differential photometric indices for σ Ori E, which were then calibrated against nearby σ Ori AB using the colors published by Echevarria et al. (1979). We do not employ a photometric standard star, since we are primarily interested in *changes* to the brightness of σ Ori E. The resulting light curves, phased over the star's rotation period, are shown in Fig. 1.

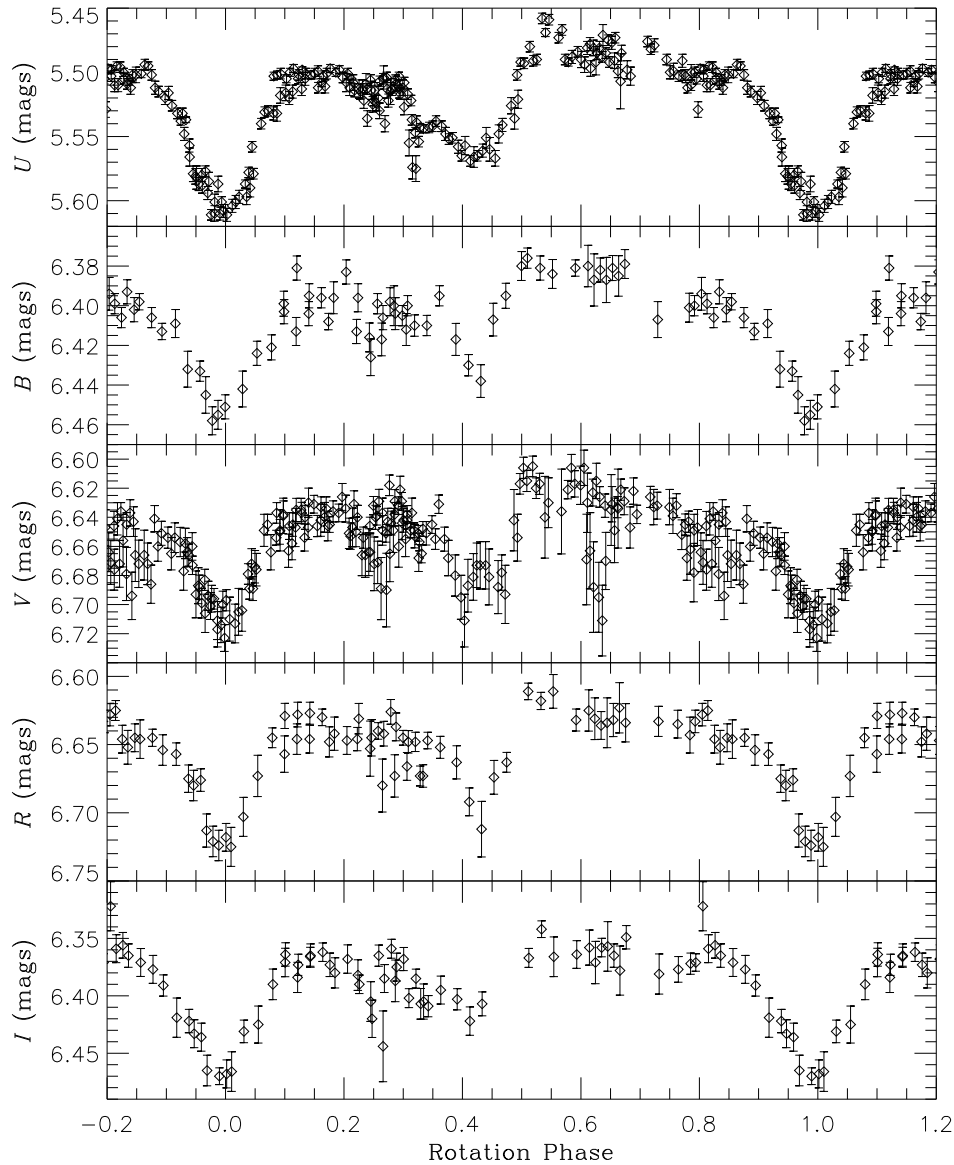


Figure 1. Observed *UBVR* light curves, phased over an adopted rotation period of 1.190858 d.

2. Discussion

In Fig. 2, we compare our *U*-band observations with both the *u*-band light curve published by Hesser et al. (1977) and the predictions of the T05 RRM model. The primary minimum in both light curves arises when dense magnetospheric plasma transits the stellar disk; the depth and timing of this minimum in the RRM model is adjusted to match the observations, and agreement between the two is therefore guaranteed. The RRM model underestimates the star's

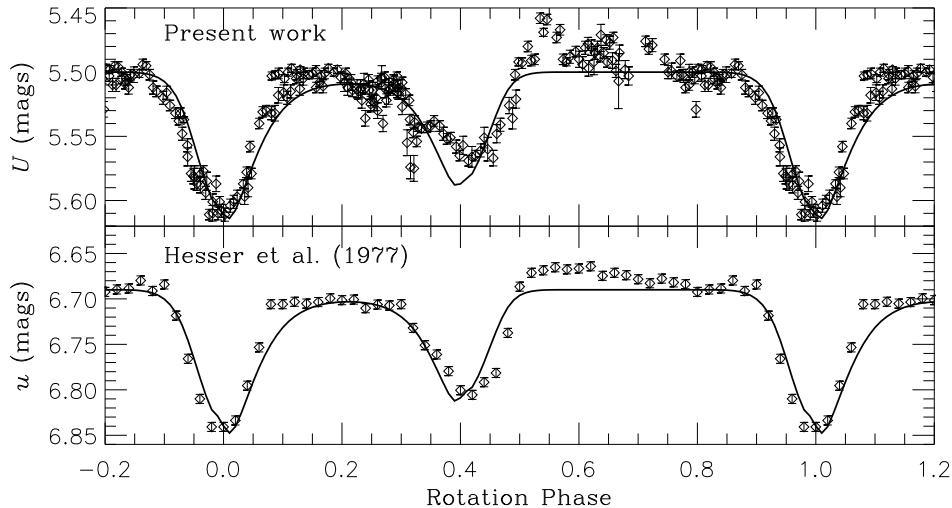


Figure 2. Comparison between the Strömgren u -band light curve obtained by Hesser et al. (1977), the Johnson U -band light curve presented here, and the RRM model for σ Ori E devised by T05 (solid line).

brightness at first maximum, when the magnetosphere is viewed near edge-on. The deficit is most significant in the U -band observations, but can also be seen in the u -band data. This suggests that the star's inclination and/or magnetic obliquity may be larger than the values ($i = 75^\circ$, $\beta = 55^\circ$) adopted by T05.

The secondary light minimum is situated at the same phase ~ 0.42 in both observational datasets, indicating that the star's magnetic field configuration has been stable over the past three decades. However, the minimum is weaker in the U -band curve, suggestive of a change in the relative distribution of plasma within the magnetosphere. The pseudo-emission feature in the u -band data at phase ~ 0.55 , which the RRM model is unable to reproduce, is still present in the U -band curve. It seems likely that this feature, which is also seen in the BVR data (Fig. 1), corresponds to a photospheric inhomogeneity near the magnetic pole. We note that the period $P = 1.190858 \pm 0.000001$ d required to achieve correct phasing is slightly longer than that found by Hesser et al. (1977). Confirming suggestions of period lengthening by Reiners et al. (2000), this may represent evidence for the first case of magnetic spin down in an early-type star (although see also Mikulášek, these proceedings).

Acknowledgments. This research has been partially supported by US NSF grant AST-0097983 and NASA grant LTSA04-0000-0060.

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